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A Follow-up Study on the Persistence of Savings from the Retrocommissioning of Ten Buildings on a University Campus: Preliminary Results

Submitted by:

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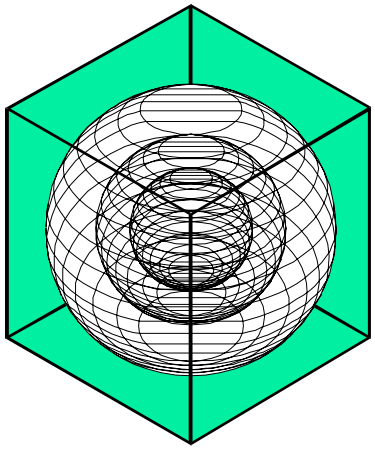

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Executive Summary

A study has been initiated to provide follow-up analysis on the persistence of savings achieved from the retrocommissioning of ten buildings on a university campus. The buildings were originally commissioned in 1996, and the energy savings achieved over the next four years were tracked to evaluate their persistence levels. This study has now expanded the time frame after commissioning to an average of eight years by analyzing the energy consumption data for each building for the most recent year that valid data were available for the building.

Preliminary results show high aggregate levels of savings persistence over the eight year average period for each building. The aggregate chilled water usage for the most recent data year for the ten buildings was virtually identical with the 1997 level, and only 56% of the baseline consumption. The aggregate hot water usage for the most recent data year for the ten buildings showed savings of 60.6% vs. savings of 66.4% for 1997, while the aggregate electricity savings were 22.9% vs. 11.5% for 1997. However, virtually all of the change in electricity use occurred in two buildings where it can not be regarded as a result of commissioning activities. The two buildings that required follow-up commissioning in 2001 (Kleberg and G.R. White) showed greater thermal savings after the follow-up than in 1997, suggesting that the 2001 effort was more thorough than that in 1997. If they are excluded from the analysis, the aggregate CHW savings of the other eight buildings decreased from 45.0% in 1997 to 36.3% in the most recent year while HW savings decreased from 54.4% to 40.5%. Even these savings show a high level of persistence over an average period of more than seven years.

More analysis is needed to verify the quality of the data used in these comparisons, as well as to fill in some missing years where data are available. Follow up investigation is also needed to compare current building operating parameters with those in place just after commissioning and in the year 2000, to get a clearer picture of why changes in savings have occurred in each building.

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Acknowledgements

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Introduction

A study was performed in the year 2001 to determine the level of persistence of savings resulting from the retrocommissioning of ten buildings on the Texas A&M University campus (Cho, 2002). Each of the buildings evaluated had been commissioned in 1996 or early 1997, resulting in three to four years of post-commissioning data available for analysis at the time of the study. It was found from this study that one year after commissioning, an average of 44.8% chilled water savings, 67.3% hot water savings, and 11.5% electricity savings had occurred over the ten buildings. By the end of the year 2000, four years after commissioning, the average savings for the ten buildings had degraded to 35.1% for chilled water, 49.7% for hot water, and 10.7% for electricity. Further analysis of the buildings revealed that a large majority of the degradation of savings was the result of mechanical problems discovered in two of the buildings, G. Rollie White and Kleberg. The savings for the other eight buildings were found to have a high level of persistence over the period studied.

The purpose of the current study is to provide follow-up analysis of the energy consumption of the same ten buildings, to further evaluate how the original savings have persisted over a significantly longer period of time. The most recent year with valid energy consumption data has been examined for each building, ranging from 2001 to 2005-2006. The original metering in many of the buildings studied became faulty in recent years, displaying either highly suspicious or obviously inaccurate data. For five of the buildings, new meters have been installed within the last year and a half, with good results. These buildings are those with data from 2005-2006. For the remaining five buildings, the data for each recent year were analyzed, and the most recent year wherein the data seemed plausible was selected for each building. Initial analysis of these data and their implications on the persistence of savings in each building has been carried out. From this analysis, it is hoped that causes of degradation or persistence can be identified, and recommendations can be formulated to maximize the persistence of commissioning savings, and thereby the overall value of commissioning.

Methodology

The same methodology for determining savings used in the original study has been applied to the recent data. Three and four parameter change point models were created using the measured consumption data, and the models were then used to normalize the data to a common weather year, which was chosen to be the year 1995, since this was the year used in the original study. The change point models used are given in the Appendix.

Preliminary Results

The results of the first study combined with the updated recent consumption data for each of the ten buildings are shown in Table 1.

Table 1. Energy usage data for ten buildings from pre-commissioning baseline to most recent data year.

Building Name	Type	Baseline Use (MMBtu) (MWh) / yr	1997		1998		1999		2000		2001		2002		2003		2004		2005-2006	
			Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)	Use (MMBtu) (MWh) / yr	Saving (%)
Blocker	CHW	22,955	16,723	27	19,530	15	20,164	12	21,083	** 8					20,850	9				
	HW	8,735	4,093	53	1,676	81	3,330	62	4,344	** 50					6,367	27				
	Elec	4,832	3,773	22	3,883	20	3,936	19	3,859	20					3,583	26				
Eller O&M	CHW	30,625	18,846	38	18,660	39	19,012	38	20,360	34							21,805	29		
	HW	7,584	2,578	66	1,154	85	1,831	76	4,712	38							NA	NA		
	Elec	4,891	3,698	24	3,675	25	3,823	22	3,874	21							3,841	21		
G.R.White Coliseum	CHW	18,872	8,717	54	8,511	55	14,548	23	15,858	16									6,837	64
	HW	21,155	6,091	71	549	97	4,923	77	10,111	52									3,276	85
	Elec	1,480	1,297	12	1,168	21	1,171	21	1,291	13									1,028	31
Harrington Tower	CHW	14,179	7,109	50	8,420	41	7,660	46	9,032	36									7,103	50
	HW	6,896	2,603	62	914	87	1,629	76	3,519	49									2,966	57
	Elec	1,666	1,297	22	1,336	20	1,341	20	1,353	19									1,293	22
Kleberg Building	CHW	59,271	34,864	41	34,969	41	36,731	38	41,965	29									20,964	65
	HW	40,812	6,523	84	1,215	97	8,030	80	10,591	74									7,421	82
	Elec	5,511	5,458	1	5,067	8	4,778	13	4,684	15									3,320	40
Koldus Building	CHW	* 21,964	12,177	45	12,988	41	12,740	42	11,804	46									12,487	43
	HW	2,103	704	67	399	81	634	70	649	69									3,488	-66
	Elec	2,850	2,511	12	2,597	9	2,624	8	2,592	9									2,553	10
Rich. Petroleum	CHW	28,526	13,599	52	15,637	45	15,078	47	17,702	38							17,625	38		
	HW	* 18,227	6,565	64	5,588	69	5,098	72	2,171	88							8,882	51		
	Elec	1,933	1,898	2	1,914	1	1,991	-3	2,153	-11							2,155	-11		
VMC Addition	CHW	40,892	23,115	43	24,080	41	22,915	44	23,307	43			25,849	37						
	HW	3,569	887	75	2,041	43	2,097	41	2,051	43			3,203	10						
	Elec	4,186	3,996	5	4,140	1	4,236	-1	4,056	3			4,169	0						
Wehner CBA	CHW	19,193	12,327	36	13,339	31	12,530	35	11,609	40	13,490	30								
	HW	13,393	10,876	19	9,715	27	6,581	51	6,350	53	7,309	45								
	Elec	2,555	2,410	6	2,446	4	2,552	0	2,581	-1	2,529	1								
Zachry Engr. Center	CHW	40,824	16,737	59	17,377	57	18,148	56	20,225	50									20,440	50
	HW	7,676	1,630	79	3,230	58	2,226	71	4,271	44									3,623	53
	Elec	7,502	6,762	10	6,793	9	7,099	5	6,955	7									4,377	42
Type		*Total*	*Total*	***Average***	*Total*	***Average***	*Total*	***Average***	*Total*	***Average***										
Chilled Water		297,298	164,215	**44.8**	173,509	**41.6**	179,527	**39.6**	192,946	**35.1**										
Hot Water		130,149	42,549	**67.3**	26,482	**79.7**	36,380	**72.0**	65,508	**49.7**										
Electricity		37,407	33,100	**11.5**	33,018	**11.7**	33,552	**10.3**	33,399	**10.7**										

The main focus of the current study is a comparison of the most recent consumption data with that of the 1997, or post-commissioning data to determine the level of persistence of commissioning savings. From the table it can be noted that overall the savings appear to have persisted to a high degree, with a few notable exceptions. The chilled water and hot water savings for the Blocker Building have degraded substantially to less than half the 1997 savings, though electricity savings increased by 4%. The Eller O&M building chilled water savings in 2004 were about ¾ the 1997 savings while electricity savings were nearly 90% of the 1997 savings. Good hot water data were not available for the building after the year 2000. The G. Rollie White Coliseum appears to have achieved significantly more chilled water and electricity savings in 2005-2006 than it had at any other time studied, with chilled water savings increasing from 54% in 1997 to 64% in 2005, and electricity savings more than doubled. Hot water savings increased from 71% to 85%. This building had significant follow-up commissioning in 2001 following a controls failure and is subject to a great degree of variation in its usage due to the nature of the building (a volleyball arena), so more investigation is needed to determine whether these or other factors are responsible for these higher levels of savings. Harrington Tower saw savings in 2005-2006 that were very consistent with the 1997 savings for chilled water, hot water, and electricity consumption, with allbeing 90-100% of 1997 savings. Kleberg was found to have chilled water and electricity savings that were substantially higher in 2005-2006 than they had been in 1997, with chilled water savings increasing from 41% to 65% and electricity savings increasing from 1% to 40%. Hot water savings for the building closely matched the 1997 level. Kleberg also had substantial follow-up commissioning in 2001 after some mechanical and controls failures. However, the major decrease in electricity consumption is puzzling at this time and more investigation is needed to determine why this occurred.

The Koldus Building showed good consistency in chilled water and electricity savings from 1997 to 2005-2006. However, the hot water consumption was found to have increased dramatically, resulting in highly negative savings for the year 2005-2006. Further investigation is needed to determine if a legitimate reason exists for this change, or if the data is bad. The Richardson Petroleum Building saw a decrease in savings in chilled water, hot water, and electricity consumption in 2004 as compared with the 1997 levels, with chilled water and hot water savings and chilled water savings about ¾ of 1997 levels. Electricity consumption increased to about 10% above the baseline level.. The VMC Addition experienced a decrease in chilled water savings from 43% in 1997 to 37% in 2002, and hot water consumption basically returned to the 1997 levels. The electricity consumption in 2002 had essentially returned to its pre-commissioning baseline level, a 5% increase in consumption from 1997.

The Wehner Building underwent renovation in 2002 and had an Annex added that increased building area and the number of air handling units. The building pumps were replaced with larger ones, but the same pumps now serve both the main building and the Annex, without separate metering. Therefore, the year 2001 was the latest year available with data solely from the original building. More recent data are being analyzed to determine if a scaling factor based on building area can be implemented with meaningful results. The 2001 data showed a slight decrease in chilled water and electricity savings from the 1997 levels (chilled water decreased from 35% to 30% and electricity from 6%

to 1%), but hot water savings increased from 19% to 45%. This increase was already being seen in 1999, as noted in Table 1.

The Zachry Engineering Center chilled water savings in 2005-2006 were 50% compared to 9% in 1997. Hot water savings degraded from 79% to 53% in this time period. However, electricity consumption decreased dramatically, by 32% from the 1997 level. More investigation is needed to determine if these changes can be reasonably accounted for, or if the electricity data is questionable. It is very unlikely that this change is related to commissioning activity.

Figures 1-3 below trend the chilled water, hot water, and electricity savings in the ten buildings over the years studied.

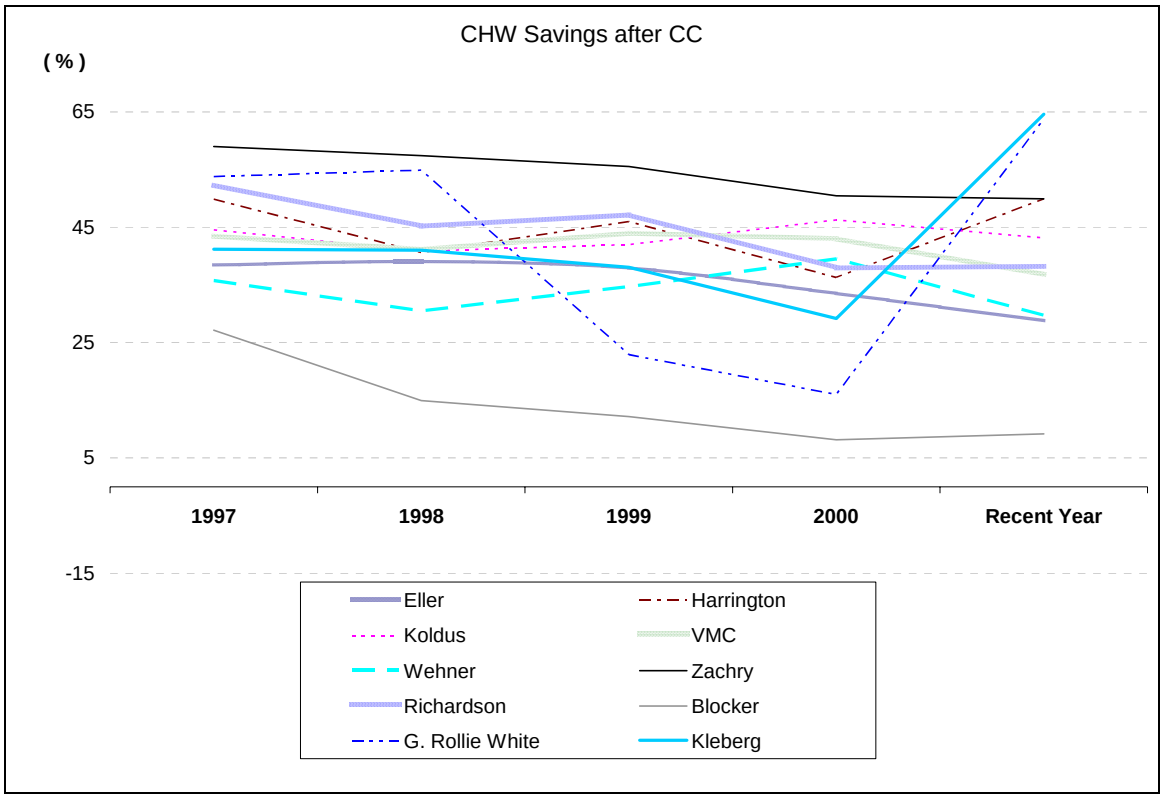

Figure 1. Trend of chilled water savings in the 10 buildings over the years studied.

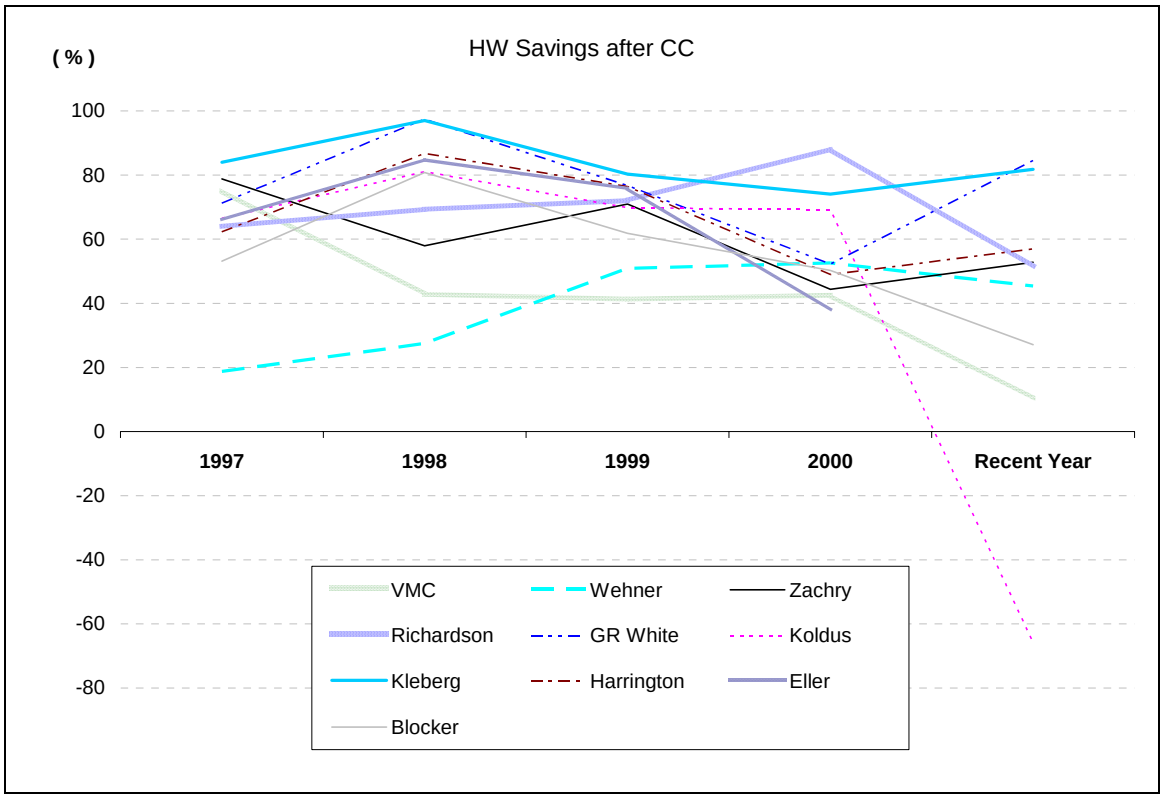

Figure 2. Trend of hot water savings in the 10 buildings over the years studied.

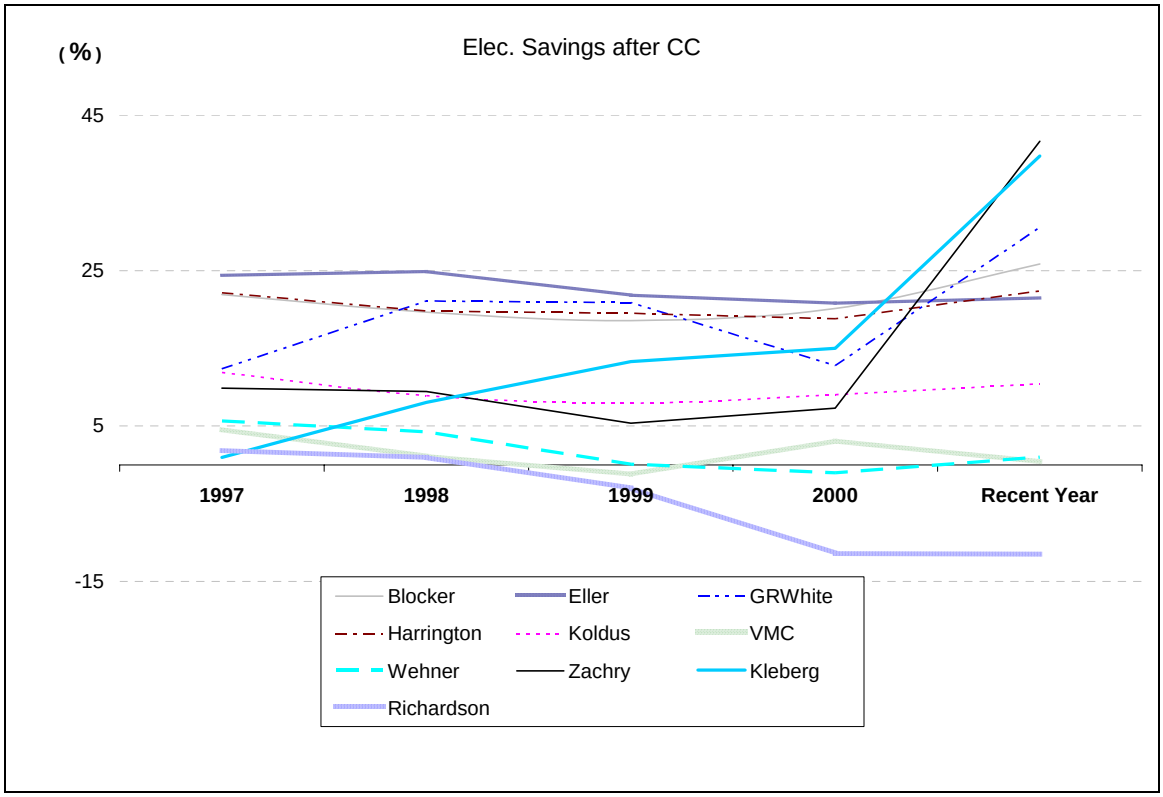

Figure 3. Trend of electricity savings in the 10 buildings over the years studied.

It is technically not accurate to sum up the energy consumption values for the ten buildings during the "recent year" category and assert this as a total to compare to the yearly totals in Table 1, since this year is 2001 for one, 2002 for one, 2003 for one, 2004 for two and 2005-2006 for five of the buildings. However, as a means of comparison, the sum total of chilled water usage during the most "recent year" for each of the ten buildings is 167,450 MMBtu, only 2% higher than the 164,215 MMBtu consumed in 1997, and only 56% of the baseline consumption. The sum total of hot water usage for the ten buildings during the most "recent year" (assuming the year 2000 consumption for Eller) is 51,247 MMBtu, as compared with 42,549 MMBtu in 1997, but is still only 39% of the baseline consumption. And the sum total electricity consumption for the ten buildings during the most "recent year" is 28,848 MWh, as compared with 33,100 MWh in 1997 which represents an approximate doubling of the original electric savings of 4307 MWh. As mentioned, some of the most recent electricity consumption data need to be verified. But this comparison appears to indicate that savings have persisted rather well in the ten buildings as a whole over an average period of about 8 years after commissioning. It must be noted that at least two of these buildings suffered combined savings degradation of approximately $150,000/year before 2001 followed by additional commissioning activity to resolve component and control issues that caused the savings degradation (reference Claridge et al. 2004)

Additional Work Needed

As already noted, more investigation is needed to verify that the data are accurate for a few of the savings values presented. In addition to this, however, several other items need to be addressed to make the overall study more meaningful. More research will be conducted to determine what has happened in each of the buildings since the year 2000, when the original study was completed. In particular, any follow-up commissioning work needs to be documented. It is also planned to obtain the most current set points in place in each of the buildings, so that these can be compared to those in place at the time of commissioning, just after commissioning, and in the year 2000. This comparison will help to determine if the changes in energy savings noted in the buildings can be ascribed to operational parameter changes, or if other issues were at play.

As mentioned previously, the more recent data for the Wehner building will be analyzed to determine whether persistence in this building can be addressed meaningfully, given the space that was added to the building. This would increase the average time after commissioning that data is available for each building. In addition, some of the gaps now present between the year 2000 data for each building and the most recent year available can be filled, as some of the buildings have valid data for the interim years. This work needs to be completed so that a more complete picture can emerge as to the savings behavior through this time period.

Finally, when the additional information has been collected and analyzed, the preliminary conclusions presented in this report will be revised if necessary. The investigation will also seek to identify common factors that allow savings to persist and those factors that influence the degradation of savings. This would enable the lessons

learned from this study to be incorporated into future commissioning projects to increase their overall effectiveness and value.

Conclusions

Initial comparisons of energy consumption between the immediate post-commissioning period and the most recent year of data available have revealed that aggregate savings for the ten buildings have persisted very well for an average of eight years after commissioning. The aggregate chilled water usage for the most recent data year for the ten buildings was virtually identical with the 1997 level, and only 56% of the baseline consumption. The aggregate hot water usage for the most recent data year for the ten buildings showed savings of 60.6% vs. savings of 66.4% for 1997, while the aggregate electricity savings were 22.9% vs. 11.5% for 1997. However, virtually all of the change in electricity use occurred in two buildings where it can not be regarded as a result of commissioning activities. The two buildings that required follow-up commissioning in 2001 (Kleberg and G.R. White) showed greater thermal savings after the follow-up than in 1997, suggesting that the 2001 effort was more thorough than that in 1997. If they are excluded from the analysis, the aggregate CHW savings of the other eight buildings decreased from 45.0% in 1997 to 36.3% in the most recent year while HW savings decreased from 54.4% to 40.5%. Even these savings show a high level of persistence over an average period of more than seven years. More analysis is needed to verify the quality of the data used in these comparisons, as well as to fill in some missing years where data are available. Follow up investigation is also needed to compare current building operating parameters with those in place just after commissioning and in the year 2000, to get a clearer picture of why changes in savings have occurred in each building.

References

Chen, Hui, Song Deng, Homer Bruner, David Claridge and W.D. Turner, "Continuous Commissioning^{SM} Results Verification And Follow-Up For An Institutional Building - A Case Study," *Proceedings of the 13th Symposium on Improving Building Systems in Hot and Humid Climates*, May 20-23, 2002, Houston, TX, pp. 87-95.

Cho, Soolyeon, "The Persistence of Savings Obtained from Commissioning of Existing Buildings," *M.S. Thesis*, Mechanical Engineering Department, Texas A&M University, ESL-TR-02-05-01, May, 2002, 347 pp.

Claridge, D.E., Turner, W.D., Liu, M., Deng, S., Wei, G., Culp, C., Chen, H. and Cho, S.Y., "Is Commissioning Once Enough?," *Solutions for Energy Security & Facility Management Challenges: Proceedings of the 25th WEEC*, Atlanta, GA, pp. 29-36, Oct. 9-11, 2002.

Claridge, D.E., Turner, W.D., Liu, M., Deng, S., Wei, G., Culp, C., Chen, H., and Cho, S., “Is Commissioning Once Enough?” *Energy Engineering*, Vol. 101, No. 4, 2004, pp. 7-19.

Liu, C., Turner, W.D., Claridge, D., Deng, S. and Bruner, H.L., “Results of CC Follow-Up in the G. Rollie White Building,” *Proc. 13th Symposium on Improving Building Systems in Hot and Humid Climates*, May 20-23, 2002, Houston, TX, pp. 96-102.

Turner, W.D., Claridge, D.E., Deng, S., Cho, S., Liu, M., Hagge, T., Darnell, C., Jr., and Bruner, H., Jr., "Persistence of Savings Obtained from Continuous Commissioning℠," *Proceedings of the 9th National Conference on Building Commissioning*, Cherry Hill, NJ, pp. 20-1.1 - 20-1.13, May 9-11, 2001.

Appendix

The three parameter and four parameter models used for each building to normalize savings for each year to a common weather year (1995) are presented in the table that follows.

Building Name	Energy Type	Model Type	Year	Ycp	LS	RS	Xcp	R^2	RMSE	CV RMSE
Blocker	CHW	4P-CP	Baseline	63.0061	0.6980	2.1238	75.3820	0.54	14.5412	24.2%
			1997	40.0913	0.3125	1.6082	71.0380	0.44	12.7551	25.2%
			1998	46.3349	0.6078	1.5567	67.7640	0.54	13.3120	24.1%
			1999	51.0292	0.4829	1.1565	68.8660	0.49	11.3215	20.5%
			2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a
			2003	53.4566	0.6252	1.0778	68.0417	0.7319	6.7229	11.7%
	HW	3P-CP	Baseline	20.7566	-0.1655	0.0000	88.4140	0.06	9.8100	40.1%
			1997	0.0000	-1.0047	0.0000	78.6400	0.43	9.8400	168.8%
			1998	2.6400	-0.8757	0.0000	58.8720	0.17	8.1500	200.7%
			1999	1.0332	-0.4462	0.0000	87.3280	0.28	9.8300	108.1%
			2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a
			2003	11.9701	-0.6693	0.0000	73.8750	0.6754	5.0935	30.2%
Eller O&M	CHW	4P-CP	Baseline	70.0160	0.7716	1.9658	64.5220	0.42	24.0906	28.8%
			1997	42.6854	0.4331	2.4375	71.0380	0.57	14.9012	26.6%
			1998	37.2655	0.6276	2.4280	67.1560	0.68	14.8923	28.6%
			1999	43.9494	0.6145	2.2005	69.9520	0.61	13.8436	27.6%
			2000	41.1108	0.2551	1.9936	65.6080	0.58	14.9134	26.7%
			2004	48.7953	0.8663	3.0525	70.0800	0.93	6.3129	10.6%
	HW	3P-CP	Baseline	3.5820	-0.8960	0.0000	88.4140	0.34	16.1600	87.2%
			1997	0.0000	-0.3895	0.0000	87.3280	0.21	9.4100	160.4%
			1998	0.5225	-0.6505	0.0000	65.0280	0.23	7.9800	270.0%
			1999	0.0000	-0.3302	0.0000	84.0700	0.29	6.9000	131.4%
			2000	0.0728	-0.7960	0.0000	85.1560	0.33	15.3200	118.3%
G.R. White	CHW	3P-CP	Baseline	38.8635	0.0000	0.7286	52.6200	0.21	12.9600	27.4%
			1997	16.4654	0.0000	1.1226	67.7800	0.56	8.1000	30.8%
			1998	13.5198	0.0000	1.2391	65.6080	0.48	10.5500	44.8%
			1999	44.7645	0.0000	-0.2930	53.6620	0.03	19.1500	48.0%
			2000	44.4863	0.0000	-0.4304	76.7320	0.01	17.9800	41.5%
			2005-2006	2.2689	0.0000	1.7520	63.2800	0.66	11.3900	55.8%

	HW	3P-CP	Baseline	54.4475	-0.4630	0.0000	72.8080	0.12	12.0300	20.4%
			1997	8.0351	-0.4508	0.0000	88.4140	0.30	9.5800	63.0%
			1998	0.5709	-0.4099	0.0000	59.0920	0.19	4.3300	288.8%
			1999	2.3353	-0.5812	0.0000	88.4140	0.16	18.3300	135.6%
			2000	10.0806	-0.9172	0.0000	88.4360	0.29	19.0100	74.1%
			2005-2006	4.1756	-0.8061	0.0000	69.5800	0.61	5.3783	62.9%
Harrington Tower	CHW	4P-CP	Baseline	18.4888	0.0556	1.1712	52.8460	0.70	8.7469	25.2%
			1997	13.8290	0.3095	1.0962	67.7800	0.63	7.4702	38.6%
			1998	16.8813	0.5158	1.2493	67.1560	0.64	9.2989	39.6%
			1999	17.1942	0.2715	1.5437	73.2100	0.59	8.4634	40.0%
			2000	16.4897	0.2716	1.5009	68.0458	0.62	9.5762	37.9%
			2005-06	17.6455	0.3290	1.4392	74.6200	0.79	4.8952	23.6%
	HW	3P-CP	Baseline	4.9804	-0.9599	0.0000	83.2120	0.41	13.9300	75.6%
			1997	0.4346	-0.3489	0.0000	88.4140	0.20	9.5700	133.4%
			1998	1.3976	-0.5710	0.0000	57.5800	0.17	5.5700	227.6%
			1999	3.0145	-1.4737	0.0000	52.5760	0.29	7.1700	153.0%
			2000	6.6921	-1.7171	0.0000	56.5417	0.75	6.9600	37.7%
			2005-06	2.2383	-0.7464	0.0000	73.3600	0.93	1.9600	26.3%
Kleberg	CHW	3P-CP	Baseline	129.7029	0.0000	1.5598	48.8320	0.15	31.6500	21.8%
			1997	80.5380	0.0000	3.4612	72.1240	0.24	34.4400	36.0%
			1998	76.2818	0.0000	3.7286	70.2840	0.32	36.1900	36.3%
			1999	71.1613	0.0000	4.4607	67.7800	0.44	37.0000	33.2%
			2000	83.4304	0.0000	2.5394	59.0920	0.28	42.2400	36.7%
			2005-2006	21.5507	0.9625	3.7795	62.0200	0.93	10.0783	14.9%
	HW	3P-CP	Baseline	104.7819	-0.9946	0.0000	71.8360	0.07	36.2800	30.4%
			1997	0.1576	-1.0359	0.0000	86.2420	0.21	27.6400	155.2%
			1998	4.5778	0.1977	0.0000	71.3460	0.11	5.2400	155.9%
			1999	11.3633	-4.6660	0.0000	59.0920	0.35	25.9300	149.2%
			2000	5.5329	-1.2237	0.0000	88.4140	0.20	34.2500	117.8%
			2005-2006	8.3183	-0.9424	0.0000	80.9200	0.44	11.6100	67.6%

Koldus	CHW	4P-CP	Baseline							
			1997	23.6651	0.1321	0.9319	61.2640	0.59	7.5280	20.6%
			1998	24.1391	0.1612	1.2409	62.9000	0.74	7.2738	20.0%
			1999	29.3635	0.3226	1.2273	68.8660	0.66	7.4427	21.4%
			2000	23.9536	0.1915	0.7649	60.1780	0.53	7.8763	24.3%
			2005-2006	20.9720	0.4082	1.1336	59.0000	0.84	5.5739	15.4%
	HW	3P-CP	Baseline	5.6277	-0.0386		63.2840	0.02	2.2400	37.4%
			1997	-0.0181	-0.1621		79.7260	0.44	2.0600	103.9%
			1998	0.0319	-0.0938		78.8600	0.43	1.2600	125.4%
			1999	0.1004	-0.0853		88.4140	0.35	1.6000	87.2%
			2000	0.1062	-0.0871		88.4140	0.31	1.7900	100.6%
			2005-2006	5.2705	-0.2194		88.7600	0.59	2.3500	26.0%
Rich. Pertoleum	CHW	3P-CP	Baseline	77.4038		0.2230	74.3100	0.02	4.5800	5.7%
			1997	25.1161		1.8736	67.7800	0.62	10.7300	27.9%
			1998	23.1531		1.7634	60.7720	0.68	11.9500	27.5%
			1999	21.6462		1.9596	62.3500	0.69	12.3200	29.2%
			2000	27.3230		1.8251	60.1780	0.45	18.7100	33.8%
			2004	31.3538		2.1403	65.6000	0.88	6.0952	12.7%
	HW	3P-CP	Baseline							
			1997	8.1443	-0.7304		81.8980	0.38	11.6900	73.1%
			1998	7.1159	-0.6807		79.9240	0.40	10.0500	66.9%
			1999	8.5638	-0.3775		82.9840	0.28	7.7500	56.7%
			2000	7.5316	0.3074		67.7800	0.03	9.1400	132.3%
			2004	11.8618	-1.7037		72.3200	0.78	8.9504	37.2%
VMC Addition	CHW	3P-CP	Baseline	100.0292		1.8944	68.2480	0.17	24.1200	19.3%
			1997	21.9141		4.1272	62.3500	0.65	28.1900	44.4%
			1998	21.7759		3.8092	60.1780	0.67	26.5500	39.7%
			1999	28.4349		4.7382	66.6940	0.69	24.5600	39.4%
			2000	24.5845		3.6338	61.2640	0.60	28.5600	44.7%
			2002	13.4721		4.5441	58.8333	0.94	11.9570	18.3%

	HW	3P-CP	Baseline	4.5874	-0.2645		88.8560	0.04	8.0600	122.0%
			1997	0.1557	-0.1689		81.8980	0.20	4.3700	179.7%
			1998	1.8335	-0.2966		80.8120	0.51	3.7000	66.8%
			1999	0.4659	-0.3122		81.8980	0.42	4.7100	99.3%
			2000	0.3392	-0.3918		81.8980	0.33	7.1800	127.2%
			2002	5.0931	-0.2148		86.2733	0.13	7.7583	84.7%
Wehner	CHW	3P-CP	Baseline	40.9478		0.7765	55.8160	0.37	9.2000	15.9%
			1997	20.8922		1.2837	62.3500	0.64	8.9700	26.6%
			1998	27.2346		1.1774	65.6080	0.51	9.5000	25.8%
			1999	23.3629		1.0929	62.3500	0.59	8.5900	25.1%
			2000	20.1977		0.9345	59.0920	0.52	9.2500	29.1%
			2001	16.1458		1.1752	52.5167	0.85	5.9926	16.7%
	HW	3P-CP	Baseline	56.6959	-0.2475		64.9500	0.07	4.5400	12.3%
			1997	20.4127	-0.6176		84.0700	0.22	15.5800	52.3%
			1998	11.4917	-1.1939		80.8120	0.51	14.7800	56.0%
			1999	9.2251	-0.4588		88.4140	0.52	6.1400	33.8%
			2000	13.9109	-0.2930		79.7260	0.16	8.1700	46.9%
			2001	16.8786	-0.7586		65.2583	0.58	5.1402	25.0%
Zachry	CHW	4P-CP	Baseline	94.9024	1.0723	3.0340	66.6940	0.62	22.4356	19.5%
			1997	36.0696	0.6688	2.0027	67.7800	0.59	14.7215	28.9%
			1998	30.6003	0.5138	1.5272	59.7080	0.67	12.0879	25.1%
			1999	42.0505	0.4535	2.0523	71.0380	0.68	10.6968	21.8%
			2000	38.3887	0.2411	1.7721	62.3500	0.64	13.0535	23.6%
			2005-2006	36.2282	0.8586	2.6947	64.5400	0.81	13.2724	22.6%
	HW	3P-CP	Baseline	19.6515	-0.9978		54.8500	0.29	9.8200	39.5%
			1997	1.4296	-0.3453		74.9200	0.40	3.5700	106.3%
			1998	5.8820	-0.2793		77.8360	0.49	3.1500	36.9%
			1999	0.7656	-0.4230		80.7280	0.65	3.8800	62.7%
			2000	7.3709	-0.2923		83.5720	0.36	5.0200	43.1%
			2005-2006	5.8123	-0.4042		77.1400	0.68	3.1400	32.9%